ORIGINAL ARTICLE

Morphometric analysis of oculomotor triangle in dry human skulls and its clinical applications

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ABSTRACT

The oculomotor triangle is denoted as the "Triangle of Hakuba" or the "Hakuba's Triangle." This oculomotor triangle is a significant anatomical landmark. Oculomotor nerve, abducens nerve and part of the internal carotid artery (ICA) lie in this triangle. The determination of this analysis is to calculate the oculomotor triangle in dry processed skull bones of the south Indian population and its clinical significance. Fifty-one processed skulls of human origin were received from Anatomy Department, Basic Medical Sciences, Saveetha Dental College. Length from anterior–clinoid process (ACP) to posterior–clinoid process (PCP), length from PCP to APEX, and length from ACP to APEX were measured. Paired samples *t*-test was considered to analyze the values between the right triangle with the left triangle. From the measurements taken, the mean for the left side of the oculomotor triangle, ACP to PCP was 8.0591 ± 0.52 mm and the right side was 7.5482 ± 0.52 mm. The mean left side of the oculomotor triangle, measured from PCP to APEX was 6.73 ± 0.48 mm and the right side was 6.55 ± 0.72 mm. The mean of the left side of the oculomotor triangle, measured from ACP to APEX was 15.94 ± 0.682 mm and the right side was 16.21 ± 0.747 mm. Through this paired triangle of the cranial cavity, the horizontal section of ICA may be correlated with numerous vascular-related pathological considerations.

Key words: Anterior–clinoid process, cavernous sinus, internal carotid artery, oculomotor triangle, petrous temporal bone, posterior–clinoid process

INTRODUCTION

The oculomotor triangle is denoted as the "Triangle of Hakuba" or the "Hakuba's Triangle." This oculomotor triangle is a significant anatomical landmark. Many cranial nerves such as oculomotor nerve, abducens nerve, and horizontal vascular section of the internal carotid artery (ICA) lie in this triangle.[1] It is created by the upper part of the cavernous venous sinuses and folds of the dura: bounded laterally with petroclinoid fold (anterior) and the base by petroclinoid fold (posterior) and medially with the interclinoid fold. The purpose of this investigation is to evaluate the oculomotor triangle in dry processed skull bones of the south Indian population and its clinical significance.

Oculomotor bony triangle is important for locating and treating cancers present in medial-oriented aspect of the paired cavernous venous sinus and the lesions of the interpeduncular region.[2] The size and width of this medial triangle vary in little alterations.[3,4] The lesions are anatomical variations.

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When these lesions are located in the deep interpeduncular regions, it is difficult to clear these. By this medial triangle, the horizontal cavernous part of ICA could be seen for many vascular-related diseases and has significant association with vascular dilations (aneurysms) which forms the junction of posterior-communicating arteries.[5] The dural venous channels of the cavernous sinus at posterior-most aspect communicate with the posterior-most turn of cavernous portion of ICA along with the root of meningohypophyseal trunk, interclinoid ligament, and proximal intercavernous pathway of abducens nerve Cranial Nerve VI (CN VI).[6] Our research studies and information have caused good quality impact article publications from our team.[7-21]

The third and the fourth cranial nerve known as oculomotor and trochlear nerves (CN-III and CN-IV) in the superior wall area enter the cavernous dural venous sinus.[2] Several bony triangles were observed and analyzed in the cranial cavity for their clinical implications. All such observations provide a detailed insight into the morphometric variations between male and female sex and also between the right and left sides of the individuals which are useful for the clinicians and surgeons involved in the region concerned. Our scientist experts with their encompassing information, research experience, and data have transformed into several publications globally in well-reputed indexed journals.[22-34] The purpose of the investigation is to analyze the oculomotor triangle in dry processed skull of the south Indian population and its clinical significance.

MATERIALS AND METHODS

The present research work was done in the Anatomy Department, Basic Medical Sciences, Saveetha Dental College. The institutional research board and the Institutional Human Ethics Committee permitted the study with ethical clearance number: IHEC/SDC/ANAT/21/219. The parameters included are the length of margins of the oculomotor triangle on the left and right aspects of the cranial cavity. Measurements are taken with a digital vernier caliper. A number of people involved were two (one investigator and principal investigator). The sample was taken from 51 dry human skulls. Sampling bias was minimized by doing random sampling. Internal validity is carried out by excluding abnormal and broken skulls from the study. The length from process of anterior clinoid to process of posterior clinoid (ACP to PCP), process of posterior clinoid to pointed summit of the petrous portion of bone temporal (PCP to APEX), and process of anterior clinoid to pointed apex of petrous portion of the temporal cranial bone (ACP to APEX) was measured.

Statistical analysis

Data obtained have been tabulated using Microsoft Excel (MS Excel format). Data were then imported to SPSS software developed by IBM using the version SPSS, 23.0 (IBM SPSS (Statistical Package for the Social Sciences) statistical software, Chicago). Paired samples *t*-test has been utilized to analyze all values between the right triangle with the left triangle.

RESULTS

The morphometric measurements of the oculomotor triangle in the cranial cavity are shown in Figures 1 and 2. From the measurements taken, the mean for the left side of the oculomotor triangle, measured from ACP to PCP was 8.0591 ± 0.52 mm. The mean value of the right aspect of the oculomotor triangle, measured from ACP to PCP was 7.5482 ± 0.52 mm. The mean for the left side of the oculomotor triangle, measured from PCP to APEX was 6.73 ± 0.48 mm. The mean value of the right aspect of the oculomotor triangle, measured from PCP to APEX was 6.55 ± 0.72. The mean for the left side of the oculomotor triangle, measured from ACP to APEX was 15.94 ± 0.682 mm. The mean for the right side of the oculomotor triangle, measured from ACP to apex of the petrous bone (ACP to APEX) was 16.21 ± 0.747 mm. The morphometric measurements of various parameters of the oculomotor triangle are portrayed in Figure 3.

No significantly mentionable difference observed between left and right side measurements from ACP to PCP as $P = 0.202$ ($P > 0.05$) that was found to be not statistically significant. There was a significant difference among the left and right side measurements from the PCP to the APEX of the petrous bone as $P = 0.003$ ($P < 0.05$) that are established as statistically well significant. There was no significant difference between left and right side measurements from ACP to APEX of the petrous bone as $P = 0.63$ ($P > 0.05$) that are established as not statistically significant. The readings are denoted in Table 1.

DISCUSSION

The left and right side values do not significantly vary for the measurements of the process of anterior–clinoid to posterior–

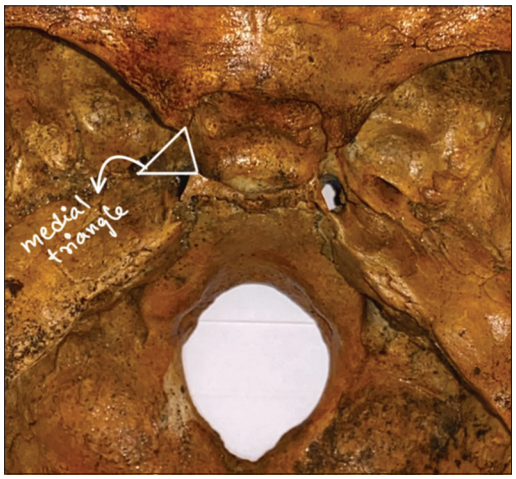

Figure 1: The left oculomotor triangle in the cranial cavity

Figure 2: The measurement of the left oculomotor triangle using vernier caliper

Table 1: The correlation of craniometric findings of the right and left side dimensions of the oculomotor triangle

Parameters (mm)	Correlation	Significance
Pair 1		
(Left) ACP to PCP	0.417	0.202
(Right) ACP to PCP		
Pair 2		
(Left) PCP to APEX	0.806	0.003
(Right) PCP to APEX		
Pair 3		
(Left) ACP to APEX	0.578	0.063
(Right) ACP to APEX		

ACP: Anterior–clinoid process, PCP: Posterior–clinoid process

clinoid and process of anterior–clinoid to apex of petrous bony part. It significantly varies for the measurements from the process of posterior–clinoid to the apex of the petrous bony part. The mean measured values of medial, lateral, and base portions are 10.4 mm × 16.1 mm × 12.2 mm, respectively. The length and width of the oculomotor triangle vary slightly in mm, 9.6 mm × 16.3 mm × 13.8 mm. From this study, the value of the oculomotor triangle differs by 8.5 mm × 15.9 mm × 6.7 mm. These are the triangles that help in the penetration of the cranial nerves 3rd, 4th, 5th, and 6th with respect to PCP and ACP and tuberculum and dorsum sellae.[35]

On correlation of morphometric measurements of the right triangular and left triangular side dimensions of the oculomotor triangle, showed that there was observed no statistical traits of significance ($P < 0.05$) between the right side to the left side of the triangle, and there was no correlation between the two sides when compared between left and right ACP to PCP and between the left and right ACP to APEX. There was a correlation between left and right PCP to APEX which was statistically significant.

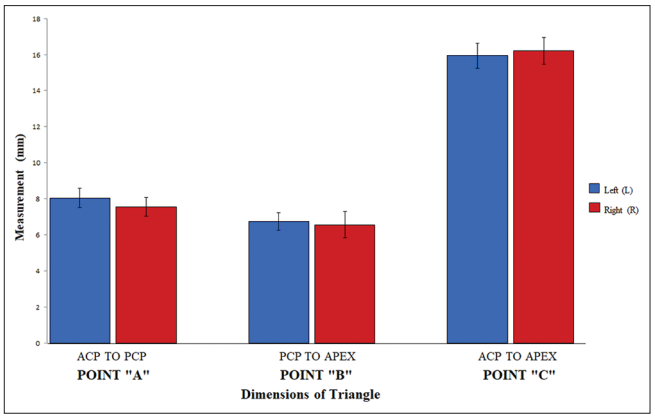

Figure 3: Bar graph shows the morphometric measurements of the mean length of the right and left oculomotor triangle from three coordinates, ACP to PCP (Point "A"), PCP to APEX (Point "B"), and ACP to APEX (Point "C"). Blue represents the left side and Red represents the right side. The X-axis signifies the various dimensions of the triangle and the Y-axis signifies the measurements in mm. All the readings are stated as mean ± standard deviation. On comparing the three coordinates, the right and left PCP to APEX in the student's *t*-test, showed $P = 0.003$ ($P < 0.05$) indicated statistically significant. ACP: Anterior-clinoid process, PCP: Posterior–clinoid process

The triangles are symmetrical with identical bilateral measurements, and the entry point of the cranial nerves are consistent. In the reported 17 cases, the dehiscence of sella diaphragm was seen in 15 cases and the string-like bonds at the stalk of pituitary gland was seen in 2 cases.[36] The greater superficial petrosal nerve is the best landmark for finding the position of the carotid canal in the petrous bone. The canal runs parallel below the nerve. Many morphometric measurements of the optic canal, carotid canal, ACP, and their anatomical variants are given in an area. Computed tomography (CT) scans need to be done using the thinnest slicing techniques.[37,38]

Future scope

The present study was done in dry human skulls. Further studies can be done in radiographic and CT scanned images for more accuracy which can be extrapolated for clinical significance.

Limitations

The disadvantage of craniometric analysis is that skulls from different geographical regions are not included in the study.

CONCLUSION

Through this paired triangle of the cranial cavity, the horizontal part of ICA can be correlated with numerous vascular-related pathological considerations. The study of this oculomotor triangle helps in many tumor clearances and has a huge clinical significance. The morphometric analysis of the oculomotor triangle is used to cure many tumors in the ICA; it also helps in viewing the oculomotor nerve and has many clinical implications; it is also a significant anatomical landmark.

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Conflicts of interest

There are no conflicts of interest.

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